

ACCESSION #: 9603110626
LICENSEE EVENT REPORT (LER)

FACILITY NAME: WOLF CREEK GENERATING STATION PAGE: 1 OF 12

DOCKET NUMBER: 05000482

TITLE: Loss of A train Essential Service Water Due to Icing on
the Trash Racks
EVENT DATE: 01/30/96 LER #: 96-002-00 REPORT DATE: 02/29/96

OTHER FACILITIES INVOLVED: DOCKET NO: 05000

OPERATING MODE: 1 POWER LEVEL: 98.3%

THIS REPORT IS SUBMITTED PURSUANT TO THE REQUIREMENTS OF 10 CFR
SECTION:

OTHER: 50.73(a)(2)(vi)

LICENSEE CONTACT FOR THIS LER:

NAME: William M. Lindsay TELEPHONE: (316) 364-8831
Manager Performance Assessment

COMPONENT FAILURE DESCRIPTION:

CAUSE: SYSTEM: COMPONENT: MANUFACTURER:
REPORTABLE NPRDS:

SUPPLEMENTAL REPORT EXPECTED: NO

ABSTRACT:

On January 30, 1996, at 0337 CST, operators in the Wolf Creek Generating Station (WCGS) Control Room manually tripped the reactor due to ice build-up on the circulating water (CW) traveling screens. The ice inhibited flow to the CW pumps and caused pressure and flow oscillations. As part of the initial actions taken when the ice was discovered, the A and B Essential Service Water System (ESWS) pumps were started. Approximately six hours later, the A ESWS pump was secured due to decreasing bay level and high differential pressure across the strainer. The cause of decreasing bay level was later determined to be ice build-up on the ESWS trash racks. The B ESWS train experienced similar icing conditions, but remained operable. Based on ESWS conditions and the inoperability of the turbine driven auxiliary feedwater pump due to a packing leak, a Notification of Unusual Event (NUE) was declared at 0846 CST. The NUE was terminated later that day, but was reinstated on January 31, 1996, due to continued icing conditions in the ESWS bays

(refer to WCNO LER 96-001-00 regarding the loss of CW and the subsequent reactor trip).

END OF ABSTRACT

TEXT PAGE 2 OF 12

PLANT CONDITIONS AT THE TIME OF EVENT

MODE: 1

Power level: 98.3%;

RCS Temperature: 584.60 Fahrenheit (F)

RCS Pressure: 2235 psig

Wind Speed: 10-25 MPH

Lake Level: 1086.4

Air Temperature: Approximately 7 Degrees F

Dewpoint: Approximately 1 Degree F

Windchill: -12 Degrees F to -33 Degrees F

Circulating Water Condenser Inlet Temperature: 32.4 Degrees F

The A and C Circulating Water (CW) pumps [KE-P] were running and the B CW pump was tagged out for preventive maintenance. The A and C Service Water (SW) pumps [KG-P] were supplying service water. Service Water pump B was tagged out for maintenance. The low flow SW pump was available. The Circulating Water Screenhouse (CWSH) traveling screens [KE-SCN] were in the manual mode on slow.

BASIS FOR REPORTABILITY

On January 30, 1996, at 0337 CST, Wolf Creek Generating Station (WCGS) Control Room operators manually tripped the reactor [AB-RCT] which resulted in actuation of the reactor protection system [JD] and multiple engineered safety features [JE]. The decision to trip the reactor was based on icing conditions on the circulating water (CW) traveling screens preventing flow to the CW pumps (refer to LER 96-001-00).

At 0747 CST, the A Essential Service Water System (ESWS) pump [BI-P] was secured due to decreasing bay level and high differential pressure across the strainer [BI-STR]. The decreasing bay level and high differential pressure were later determined to be caused by ice build-up on the ESWS trash racks [BI-RCK]. At 0846 CST, a Notice of Unusual Event (NUE) was declared based on icing in the A ESWS bay and the inoperability of the turbine driven auxiliary feedwater pump (TDAFWP) [EA-P]. The NUE was terminated at 1758 CST, on January 30, 1996.

Another NUE was declared on January 31, 1996, at 1000 CST, due to

continued icing conditions in the ESWS bays. The inoperability of the ESWS A train was due to the failure of the ESWS design to meet the environmental conditions of the original plant design basis. This event is being reported due to the discovery of a design deficiency pursuant to 10 CFR 50.73 (a)(2)(vi).

TEXT PAGE 3 OF 12

DESCRIPTION OF EVENT

Events on January 30, 1996

At 0149 CST, CW alarms annunciated in the Control Room. The Site Watch was dispatched to investigate the cause. At 0158 CST, CW traveling screen emergency alarms annunciated in the Control Room. The alarms indicate increased differential pressure across the traveling screens (lake level versus bay level). The Site Watch reported that the CW traveling screens to bays 1 and 3 were frozen and not rotating. At 0158 CST, due to oscillating SW pressure, the B ESWS pump was started and the ESWS was isolated from the SW System. At 0211 CST, the A ESWS pump was started. The operator closed the SW supply valves [KG-V] for ESWS (EF HV-23, 24, 25 and 26) and opened the return lines from ESWS to SW (EF HV-39, 40, 41 and 42). The ESWS header valves returning to the Ultimate Heat Sink (UHS) [BS] (EF HV-37 and 38) were also closed to maximize flow back through the SW header (refer to Figure One). (To ensure some warming line flow is maintained, EF HV-37 is 90% open and EF HV-38 is 65% open when in the closed position.) The system was aligned in this manner with the intent of increasing flow to the SW header while continuing to supply the existing SW loads. It was not recognized at the time that this alignment would reduce warming line flow.

At 0337 CST, the Control Room received word from the Site Watch that the CW bay levels were 12-13 feet below normal and that the low flow SW pump was vibrating. Control Room operators manually tripped the reactor, secured the CW pumps, fast-closed the Main Steam Isolation Valves [SB-ISV], broke condenser vacuum [KE-COND] and controlled the reactor coolant system (RCS) [AB] temperature with the steam generator atmospheric relief valves [SD-RV]. At 0503 CST, while stabilizing the plant in MODE 3, the Control room was notified the TDAFWP was spraying water. At 0505 CST, the Turbine Building Watch reported to the Control Room that the TDAFWP shaft gland packing was leaking and notified Maintenance. At 0514 CST, the TDAFWP inboard seal packing was determined to have failed and the pump was declared inoperable. Steam generator water levels were being maintained by the two Motor Driven Auxiliary Feedwater Pumps (MDAFWP) [BA-P]. The packing was replaced and the TDAFWP declared functional at 1411 CST, on January 30, 1996. The required

surveillances for operability will be completed during start-up from Refuel VIII.

At 0747 CST, the Control Room received a report that A ESWS bay level was low. The A ESWS pump was secured due to low discharge pressure and high differential pressure across the strainer. The Control Room declared an NUE at 0846 CST, based on the Administrative Tree of the Emergency Action Levels (EALs) due to the potential degradation of the ESWS system and the inoperability of the TDAFWP.

TEXT PAGE 4 OF 12

At 0800 CST, the relief crew Supervising operator, while in the Control Room supporting the on-shift crew, identified the abnormal ESWS/SW valve line-up and brought it to the attention of the on-shift Supervising Operator. Operators then correctly aligned the ESWS return flow to the UHS per procedure SYS EA-120, "SW System Startup."

At 1230 CST, maintenance personnel reported to the Control Room that tents and temporary heaters [HTR] were installed on both A and B ESWS bays. The heaters blew warm air onto the surface of the bays in an attempt to dissipate the ice. At 1531 CST, MODE 4 was entered. At 1543 CST, the A ESWS pump was placed in service. At 1745 CST, the A ESWS train was declared operable based on the following:

1. ESWS system was filled, vented, and running properly;
2. Supplemental heating was available and functioning (one kerosene fired space heater [HTR] per train was ducted and tented to the ESWS outer bay in front of the trash racks, and two electric heaters per train in the ESWS pumphouse, were ducted to the bays); and,
3. A decision was made to station a continuous watch to observe the bay levels, watch for icing, and monitor the kerosene fired space heaters.

At 1758 CST, the NUE was terminated based on the operability of the A ESWS train. At this time, the accumulation of frazil ice on the ESWS trash racks had not been discovered. At 1923 CST, Control Room operators secured the A ESWS due to fluctuating pump discharge pressure and flow. At 1934 CST, the Site Watch reported a decrease in the A bay level. Control Room operators reviewed the EALS, and determined that none were applicable since B ESWS was operable, the plant was in MODE 4, and no auxiliary feedwater was required. At 2002 CST, the Control Room received a report from personnel at the ESWS pumphouse that the B bay level was slowly decreasing. At 2012 CST, the Control Room commenced a RCS

cooldown using the B train Residual Heat Removal System [BP]. This caused an increase in the warming line water temperature to the B ESWS. The level in the B bay subsequently recovered.

At 2044 CST, the Site Watch reported to the Control Room that the A ESWS bay level was normal. He then rolled the A ESWS traveling screen, and it moved freely in the slow speed.

TEXT PAGE 5 OF 12

At 2100 CST, the Control Room reviewed the EALs and decided that a Site Area Emergency (SAE) would be appropriate if the B ESWS bay level decreased below 1070' (the Technical Specification limit for the UHS) or if the B ESWS pump would not run. At 2128 CST, the Site Watch reported that both A and B ESWS bay levels were equal with the lake level (1086.41). The A ESWS pump was again started at 2214 CST, and secured at 2227 CST, due to decreasing flow and pressure.

Events of January 31, 1996

At approximately 0730 CST, the Vice President Operations and the manager Operations decided that if the B ESWS bay level reduced to 1083' an Alert would be the appropriate EAL.

At 0843 CST, divers went into the A ESWS bay. At 0855 CST, the divers were out of the bay and reported that the trash racks had a build-up of ice that was preventing flow and inhibiting suction to the A ESWS pump. At 1000 CST, an NUE was declared using the Administrative Tree of the EALs due to a potential degradation of the ESWS.

At 1435 CST, emergency temporary modification (TMO) 96-007-EF was authorized to provide air sparging (introduction of air or gas into a liquid) to the A ESWS warming line. The air was supplied from a temporary air compressor [CMP] into the warming line vent line. Additionally, two air hoses were lowered into the outer bay, their open end weighted with heavy objects to prevent movement, to introduce air directly into the A ESWS outer bay. A flanged connection to the ESWS chemical injection header was also used to inject heated water from a portable tank heater into the warming line.

At 1548 CST, divers entered the A ESWS bay and found the ice blockage had moved two feet back from the trash rack. At 2045 CST, it was reported to the Control Room that the ice had cleared the bay area. At 2100 CST, per temporary procedure 96-006, the Control Room aligned SW return flow to the UHS which increased the heat load to the ESWS warming lines.

At 2248 CST, the plant entered MODE 5.

TEXT PAGE 6 OF 12

Events of February 1, 1996

At 0243 CST, the A ESWS pump was started per SYS EF-200, "Operation of the ESWS System." At 2149 CST, the Control Room authorized temporary modification (TMO) 96-008-ZE which lowered the air bubbler on the A ESWS outer bay from its previous position, of approximately 15 feet below the water level, to the bottom of the outer bay. The A ESWS pump parameters were monitored during this evolution to verify that pump performance would be acceptable with the air bubbler at any elevation in the outer bay. At 2330 CST, the Control Room received a report that temporary procedure 96-010 was complete and all the operating parameters on the A ESWS pump were acceptable.

The Vice President Plant Operations chartered an Incident Investigation Team (IIT) to perform a thorough root cause evaluation of the event. The team was composed of 26 individuals including personnel from Wolf Creek Generating Station, other nuclear utilities, vendors, the Institute of Nuclear Power operations, and the U. S. Army Corps of Engineers.

Events of February 2, 1996

At 1005 CST, the A ESWS was declared operable and the NUE terminated, based on consistent bay level and steady pressure and flow readings.

ROOT CAUSE

The root cause of this event was deficiencies in the warming line design verification on the original ESWS warming line. The errors resulted in an insufficient warming line flow rate based on the actual warming line temperature. Icing conditions were hastened by ESWS valves being misaligned for approximately 6 hours when the system was started on January 30, 1996

Detailed explanation:

The accumulation of frazil ice starts when water becomes supercooled or drops below its freezing temperature. The water will supercool first at the surface, and when turbulence is present, will mix through the entire lake depth. Small crystals of ice - frazil ice will be carried along with the supercooled water. Because the crystals are supercooled, and rapidly grow in size, they stick to any object they come into contact with, including trash racks.

A design calculation performed in 1976 specified a warming line flow rate of 4000 gpm for the prevention of frazil ice. This was determined using valid, conservative methods, but assumed that the temperature of the warming line flow would be at least 3 Degrees F above freezing. When the ESWS icing conditions developed, the estimated actual warming line temperature was approximately 1 Degree F above freezing. Using current U.S. Army Corps of Engineers, recommendations, the flow required to prevent frazil ice for a warming line flow temperature of 1 Degree F above freezing would be approximately 4,050 gpm.

The UHS and warming line piping diameters and elevations are such that portions of these lines operate with partial pipe flows and with the dry portions not vented. This condition was apparently not foreseen by the piping designer. The calculation methodology used for sizing the warming line was therefore invalid. The warming line flow rate during an accident line-up for the piping as-built configuration cannot be readily calculated or measured with a high degree of certainty. It is estimated to have been about 2500 gpm.

Warming line flow was further reduced to an estimated 1700 gpm for approximately 6 hours on January 30, 1996, due to an improper valve lineup.

Contributing Factor to the Root Cause

The incorrect alignment of the ESWS system at approximately 0200 CST, on January 30, 1996, restricted warming line flow to the ESWS intake bay trash racks and hastened the accumulation of frazil ice. This lineup was corrected at 0800 when ESWS return flow was aligned to the UHS per procedure SYS EA-120.

The ESWS valve misalignment occurred when the operator performed the ESWS/SW valve lineup, without the use of a procedure, as directed by the Shift Supervisor. The alarm response procedure failed to provide the steps required to place ESWS in service, and the specific ESWS/SWS lineup procedure was not used. This is only acceptable as an immediate response and requires a timely verification when such actions are taken without approved procedures. The root cause was a failure on the part of the Control Room crew to provide timely verification of the ESWS line-up. Imprecise communications about this lineup contributed to this event.

Failure to have the procedure in-hand increased the potential that the line-up could be done incorrectly, and made effective crew communication

and timely verification more important. Three examples of ineffective crew communications contributed to the incorrect line-up:

TEXT PAGE 8 OF 12

- o When the Shift Supervisor instructed the Reactor Operator to start the ESWS pumps, he did not fully communicate his expectations to isolate the ESWS from the SW.
- o When the Reactor Operators were walking the control boards during shift turnover, the oncoming Reactor Operator did not gain a full understanding from the on-shift Reactor Operator of the abnormal ESWS line-up.
- o When the on-coming Reactor Operator recognized the abnormal line-up, he failed to communicate his observation to his Supervising Operator.

Corrective Actions Completed for the Design Error

The below contingency plans were developed as short term corrective actions to be implemented whenever the lake temperature is 40 Degrees F or lower until long term actions are implemented. Refinements to the contingency plans will be made as appropriate based upon technical reviews.

1. Air bubblers are being maintained in each outer bay to sweep frazil ice from the ESWS trash racks. Once the lake reaches the critical environmental conditions to produce frazil ice, and the ESWS pumps, suction begin to pull supercooled water with frazil ice into the inlet, air bubblers provide a brooming, or sweeping effect upward across the trash rack to prevent or break-off frazil ice accumulation. Air bubbling also creates a high circulation ratio which promotes mixing and heat transfer. As a minimum, two air compressors are located at the ESWS pumphouse. A minimum of one air compressor is aligned for bubbling the outer bay with an additional compressor as a backup.
2. Tents will be maintained over the grating of the outer bay to provide additional freeze protection.
3. A dedicated cognizant individual will be stationed at the ESWS pumphouse 24 hours a day. This individual will: 1) monitor the air compressors, 2) monitor the tents, and 3) watch for formation of ice in the outer bays. The Control Room will be notified immediately upon compressor failure, tent degradation or ice formation in the

outer bay.

TEXT PAGE 9 OF 12

Corrective Actions to be Completed for the Design Error

1. The hydraulics of the ESWS discharge to the UHS and the warming line to the ESWS pumphouse will be changed to establish and distribute the proper amount of flow to the ESWS pumphouse warming line.

Due to the low amount of heat (approximately 1 Degree F temperature rise) available, a higher flowrate than the original design (4,000 gpm) may be required. The upper limit for this warming line flow will be dictated by the UHS cooling characteristics and the temperature range chosen for this mode of operation. To achieve the proper flow, back pressure on the ESWS discharge to the UHS must be raised downstream of the ESWS warming line tee. The back pressure orifices located upstream in the powerblock ESWS discharge lines will be re-evaluated to prevent increasing the overall backpressure on the ESWS to an unacceptable level. These corrective actions will be completed by October 1, 1996.

Corrective Actions for the Misalignment of ESWS

1. By the end of Refuel VIII, methods for tracking urgent control room actions and subsequent verification of acceptability of these actions will be evaluated.
2. Enhanced communication training will be provided to the Control Room crews. The training will stress using clear concise instructions, and not taking the watch until the relieving individual has a full understanding of all abnormal conditions. Through Instructor and Shift Supervisor interventions, communications will be critiqued to verify not only compliance with standards, but to also ensure a complete understanding of all the issues by all crew members. The need to bring abnormal conditions to the attention of supervision will be reinforced. Enhanced communication training will be provided to the Control Room crews by May 31, 1996.
3. The alarm procedures for the top-level alarms will be revised. These revisions will incorporate all expected short term operator actions into the applicable alarm procedure. The alarm procedures for the ESWS, SW system, and CW system will be revised prior to entry into MODE 4 from Refuel VIII. A priority based schedule for the remaining alarm procedures will also be developed by MODE 4. All alarm procedure revisions will be completed by October 1, 1996.

TEXT PAGE 10 OF 12

SAFETY SIGNIFICANCE

The ESWS is a safety-related system that provides cooling for components required for safe shutdown of the reactor. The ESWS consists of two redundant cooling water trains, and the system is normally not in operation. During normal plant operations, the ESWS within the power block receives water from the nonsafety-related SW system. The SW supplies ESWS loads and other station heat loads. After removing heat from plant components, the heated water is returned to the SW System and/or the UHS depending on plant conditions.

Following an engineered safety features (ESF) signal, the ESWS is isolated from the SW by automatically closing the associated ESWS/SW interface motor-operated valves [MOV]. Both ESWS pumps are automatically started after the receipt of an ESF signal. After removing heat from plant components, the water is returned to the UHS. Freeze protection for the ESWS is provided by warming lines from each ESWS discharge line to the UHS during normal, off normal, and accident conditions. The ESWS is designed so that during system operation, freezing of the trash racks is prevented due to warming lines per Updated Safety Analysis Report (USAR) Section 9.2.1.2.

The ice blockage would have prevented the A ESWS from performing its intended design function. However, the B ESWS and SW were available throughout the event.

The significance of this event was elevated based on the inoperability of the TDAFWP. The TDAFWP was declared inoperable, at 0514 CST, on January 30, 1996, due to a packing leak on the inboard seal. At 1411 CST, the packing was replaced and the TDAFWP declared functional.

PREVIOUS SIMILAR OCCURRENCES

There have been no previous occurrences where frazil ice accumulation on or inadequate warming line flow to ESWS trash racks has caused the system to become inoperable.

TEXT PAGE 11 OF 12

Figure One "Essential Service Water and Service Water System Interface" omitted.

TEXT PAGE 12 OF 12

Figure Two "Essential Service Water Pumphouse" omitted.

*** END OF DOCUMENT ***
